

Research Article



Impact of Karakoram Highway on Land use and Agricultural Development of Gilgit-Baltistan, Pakistan

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Abstract | This research paper analyses the impact of Karakoram Highway (KKH) on land use and agricultural development of Gilgit-Baltistan, Pakistan. Pakistan is gifted with a lot of natural resources in the shape of fertile agricultural lands, water resources and minerals. Agriculture is the backbone of Pakistan's economy. About 70% of its population is directly or indirectly associated with this sector. Gilgit-Baltistan is a vast mountainous and remote area in the extreme north of Pakistan.. The inhabitants of this area are mostly engaged in the agricultural sector. Before the construction of KKH, their mode of agriculture system was subsistence and crude techniques were applied due to non-availability of modern machines and techniques. This was because of the remoteness and communication gap with the rest of the country. Therefore, this study is an effort to compare and analyze the impacts of KKH on the land use and Agricultural development of Gilgit-Baltistan before and after the construction of KKH. Results show a significant change in land use and development in the agriculture sector after the construction of KKH. However, still, the land use and agriculture sectors need Government attention in land use planning, regulations, improvement of water channels, the introduction of high yielding seeds and farmer awareness.

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Introduction

Gilgit-Baltistan is a vast mountainous area in the extreme north of Pakistan. The total area of Gilgit-Baltistan is about 72,496 km². For the purpose of administration, it has been divided into ten districts i.e. Gilgit, Diamer, Hunza, Nagar, Ghanche, Ghizer, Skardu, Shiger, Kharmang and Astore. The significance of the area is evident from its geographical location as it is the juncture of Central Asia, China and South Asia. However, this important area remained cut

off from the rest of the country (Pakistan) until the inception of Karakoram Highway (KKH) in 1978. Their only source of livelihood was local agricultural production which was insufficient for the whole population. Due to the scarcity of victuals, a large number of people faced starvation during the snowy winter season. The idea of constructing this gigantic highway was proposed after the boundary settlement with China in 1963. Construction of KKH started in 1966 aiming at two main objectives; to link the vast area of Gilgit-Baltistan with the rest of Pakistan and

to develop a land route to China.

Prior to the construction of the KKH, Gilgit-Baltistan was isolated and connected with the rest of the country by air and seasonal jeep-able roads. After the intervention in the form of KKH, all the valleys are now inter-connected with main spine roads and sub-roads linked with KKH (Dani, 2001; World Bank, 2009; GoGB, 2005; AKRSP, 2012). It has greatly contributed to boosting-up the agriculture economy of Gilgit-Baltistan with farm to market roads. The diffusion of technology, development works and interaction with the wider society in Pakistan has affected the lives of the people (Kamal and Nasir, 1998; Kreutzman, 1992). The study region is the home of subsistence farming. Farmers are now being increasingly shifting into cash crops, off-farm employment and business activities. Agriculture and livestock, which were once a traditional source of sustenance, seem to be losing their ground replacing by cash crops.

Before the construction of KKH, the agro-based economy was at a very basic level. The scarce farmland and remoteness were based on subsistence and the crop self-sufficiency were limited (Clemens and Nuesser, 1995; Stellrecht, 1997; Cook and Butz, 2011). The tools used for agriculture purpose was in old fashion for centuries. The yield from agriculture was low and hard enough to survive. The entire study area was backward and had a miserable economic condition. Prior to the construction of KKH, the period from March to as far as June was considered critical, when the overwhelming majority of the population faced a shortage of staple food grain.

The main objective of this study was to observe the change in land use and agriculture of the study area after the construction of KKH. It was found that area under the built-up environment was increased and mechanization has been largely introduced throughout the Gilgit-Baltistan region. As a result, a positive impact on the agriculture sector was recorded.

Materials and Methods

Profile of the study area

Gilgit-Baltistan is a vast, mountainous and remote area in the extreme north of Pakistan, extends between 34° 40' to 37° 0' North latitude and 72° 30' to 78° 0' East longitude. Geographically, the study area (Gilgit-

Baltistan) is bounded in the North-West by Wakhan Corridor of Afghanistan, China in the North-East, Jammu and Kashmir in the East, Azad Jammu and Kashmir in the South-East, whereas the province of Khyber Pakhtunkhwa of Pakistan in the south and west. The climate of the region is characterized by warm/hot summer and cool/cold winter.

The Karakoram region has great variation in relief. The maximum relief reaches 8,610 m (K-2) the world second highest peak. The mountain system possesses some of the highest peak of the world including, Nanga Parbat (8,078 m), Rakaposhi (7,742 m) and Haramosh (7,272 m) etc. Within 60 miles' radius of Gilgit, there are over twenty lofty peaks, ranging between 5,454 m to 8,610 m above mean sea level. These mountain systems have numerous beautiful valleys ranging in length from 3 to 80 km. These valleys can be divided into three types according to their size and form. In the study area, all large and small streams finally drain into the River Indus. The mighty Indus flows through Gilgit-Baltistan mostly in narrow gorges and enters the Khyber-Pakhtunkhwa province of Pakistan. The prominent tributaries of River Indus include Gilgit, Astore, Hunza, Shigar and Shyok rivers. These rivers are mostly recharged small and large glaciers.

In Gilgit-Baltistan, numerous glaciers and rivers have worked on the region as geomorphic agents. Erosion at one place and deposition at another indicate the work of these agents and formation soil with different characteristics of parent materials. The existing soil is cultivated mainly as terraced fields and associated mainly to landforms of scree slopes, alluvial fans and morainic materials. The soil texture is predominantly coarse in the upper reaches, whereas it is fine texture in the lower flood plains. Generally, the soil is fertile and suitable for all types of crops. With the application of chemical fertilizer, the crop yield gives quite productive and more rewarding results

Data collection and analysis

In order to achieve the study objectives, data pertaining to the impact of KKH were obtained from both primary and secondary sources. Primary data is considered as the most appropriate tool in the socio-economic survey. Primary data were gathered through a questionnaire survey. Three different types of questionnaires were designed: a questionnaire for local respondents, questionnaire for Focused Group Discussions (FGD's), questionnaire for the officials of

relevant organizations. However, secondary data were collected from the concerned line agencies including the Directorate of Agriculture and Livestock, Gilgit-Baltistan, Frontier Works Organization (FWO), National Highway Authority (NHA), office of the General Manager KKH Gilgit, Office of the Commissioner and Deputy Commissioner of Gilgit, Export Promotion Bureau and Bureau of Statistics. For Land Use Land Cover analysis, multi-spectral Landsat images for the year 1996 and 2016 (twenty years' temporal resolution) were downloaded from the open source. These satellite images were classified in ArcGIS for Spatio-temporal land use land cover change analysis. In order to get micro-level impact of KKH on land use Land Cover of Gilgit-Baltistan, out of seven districts, three namely, Diamer, Gilgit and Hunza-Nagar districts were purposively selected for change detection as KKH passes through these three sample districts (Figure 1, 3, 6 and 8).



Figure 1: Location map of KKH and Gilgit-Baltistan modified after Said, 2005.

Results and Discussion

Impact of KKH on land use land cover

Land use land cover change detection is the process of exploring variation in the state of an object at a temporal scale (Yar et al., 2016). Using multi-spectral temporal satellite remote sensing data of Landsat helps in exploring changes with time-scale. The Gilgit-Baltistan has a total of seven districts and KKH passes through District Hunza-Nagar, District Gilgit and District Diamer. It is; therefore, these three sample districts were selected for land use land cover analysis. In this study, an attempt has been made to identify the impact assessment of KKH on the land use land cover of three sample districts namely, Hunza-Nagar, Gilgit and Diamer. Multi-spectral Landsat images of November 1996 and November 2016 were obtained from the open source and were analysed for change detection in twenty years' span using ArcGIS.

Land use land covers spatial data is essential for planners, decision-makers and for those who are concerned with land resource management. Land cover is actually the observed bio-physical coverage on the earth's surface and broadly includes agricultural land, forest cover, water body, bare surfaces and man-made features and infrastructures.

Land use land cover of 1996

In this research, the changes in land use land cover of the three sample districts from 1996 and 2016 have been detected. The study area selected for detailed land use land cover change analysis consists of three districts of Gilgit-Baltistan namely, Diamer, Gilgit and Hunza-Nagar. In Gilgit-Baltistan, KKH passes through these three sample districts. Figure 2 shows the Landsat 5 multi-spectral mosaic image of District Hunza-Nagar, District Gilgit and District Diamer with pre-classified image of September/November 1996. Similarly, Figure 3 indicates the Landsat 5 multi-spectral classified image of District Hunza-Nagar, District Gilgit and District Diamer of September/November 1996. In the three sample districts, the land use land cover is classified into six major categories including agriculture al land, built-up area, vegetation, water body, snow cover and barren land (Table 1).

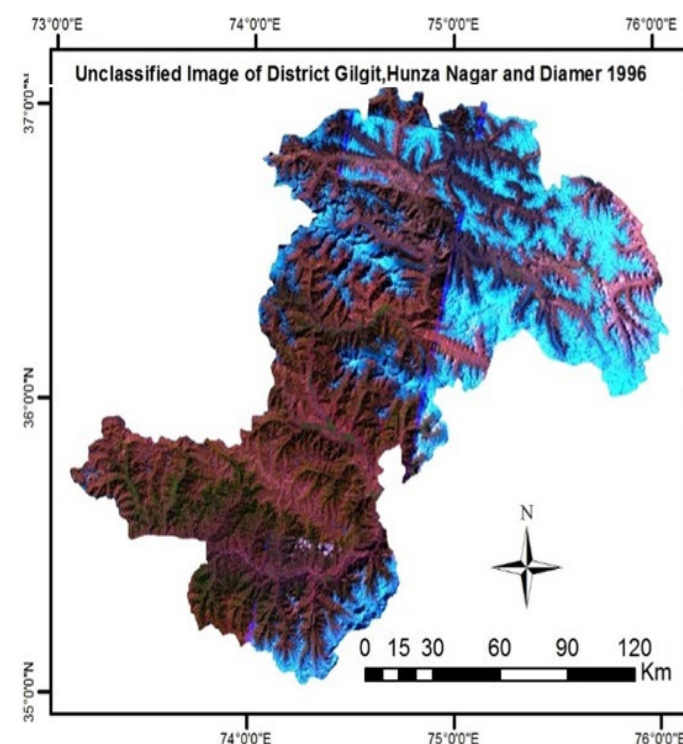


Figure 2: Landsat 5 multi-spectral image of District Hunza-Nagar, Gilgit and Diamer of September/November 1996.

Table 1: Gilgit-Baltistan, land use land cover of three sample districts, 1996.

S. No	Class Name	Area Sq. km	Area in percentage
1	Agricultural land	131.97	0.523
2	Built-up area	100.52	0.398
3	Vegetation	4,326.54	17.161
4	Water body	58.04	0.230
5	Snow cover	6,970.16	27.648
6	Barren Land	13,622.9	54.037
Total Area		25,206.96	100

Source: Extracted from Landsat image of September/November 1996.

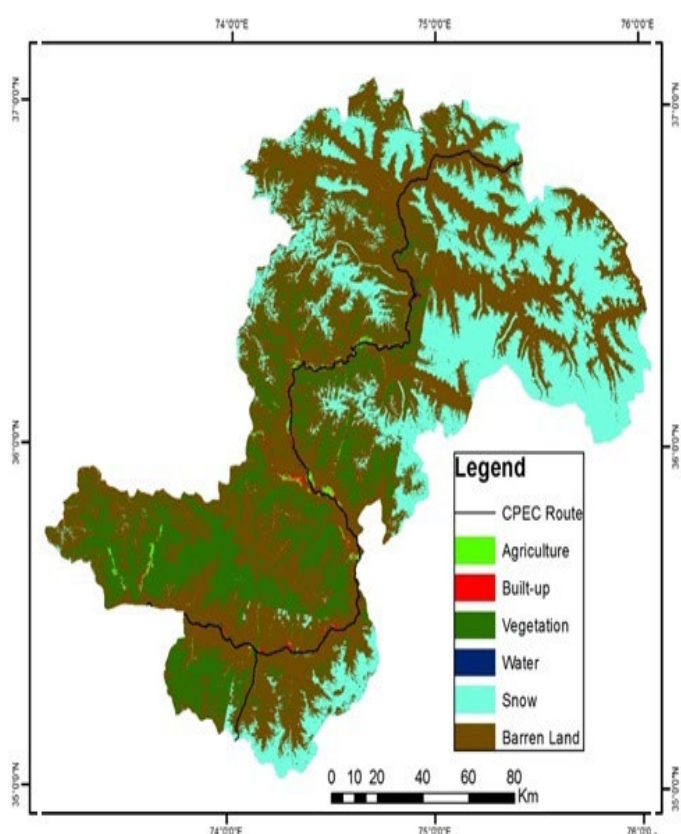


Figure 3: Landsat 5 multi-spectral classified image of District Hunza-Nagar, Gilgit and Diamer of September/November 1996.

The image analysis of Landsat data indicates that in 1996 area under the barren surface in the three sample districts was more than half (54%) of the total land cover. This is mainly due to its harsh arid and semi-arid climatic condition prevailing over the Himalayas and Karakoram mountains. It is followed by an area under snow cover, which is over 27% of the total area. This region is the largest snow cover area after the polar region as it has high altitudes with snow clad mountains and hosting thousands of small and large glaciers. Vegetation cover is a third major land use land cover category with over 17% share of the total area.

The analysis further revealed that in the three sample districts during 1996 area under agriculture was 131.97 Km² making a share of 0.523% of the total surface coverage. In Gilgit-Baltistan, agricultural land is limited to fertile river valleys. Mostly terraced field dominate the scene. Similarly, the built-up area was 100.527 Km² (0.398%) and water bodies were on 58.0442 Km² (Figure 3 and 4, Table 1).

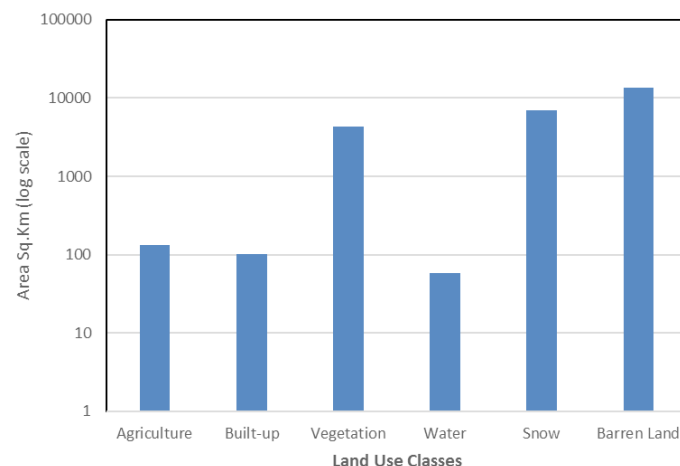


Figure 4: Gilgit-Baltistan, Land Use Land Cover of three sample districts 1996.

Land use land cover of 2016

In Gilgit-Baltistan, land use land cover is classified into six categories. The Landsat multi-spectral image analysis and resultant classification of 2016 reveal that. Similar to land use land cover classification, the signatures were selected as agricultural land, built-up area, vegetation, water bodies, snow cover and barren land. The analysis reveals that snow cover and barren land were the two major classes occupying almost 80% of the total land cover (Figure 4 and 5, Table 2). However, in rest of the four land cover classes, over 19% is under vegetation cover followed by built-up area (0.74%), agricultural land (0.36%) and water bodies (0.16%). The analysis further revealed that during 2016 the area under agriculture was 90.8799 Km² (0.360%), built-up area was 185.987 Km² (0.738%), area under vegetation cover was 4,944.4 Km² (19.615%), water bodies were on 41.0754 Km² (0.162%), Snow covers on 10,154.7 Km² (40.443%) and barren land was 9,751.92 Km² (38.679%) (Table 2; Figure 5 and 6).

Land use land cover change analysis of 1996 and 2016

Change detection analysis describes and quantifies differences between temporal image analysis of 1996 and 2016 of the same area and band combinations. The classified images of 1996 and 2016 were used to calculate the area of various land use land cover

and calculate the changes that are taking place in the time span of twenty years (1996-2016). Such kind of spatial analysis provides feedback in exploring various changes that occur in land use classes uses and the resultant changes and trend pattern detection in land uses has been recorded.

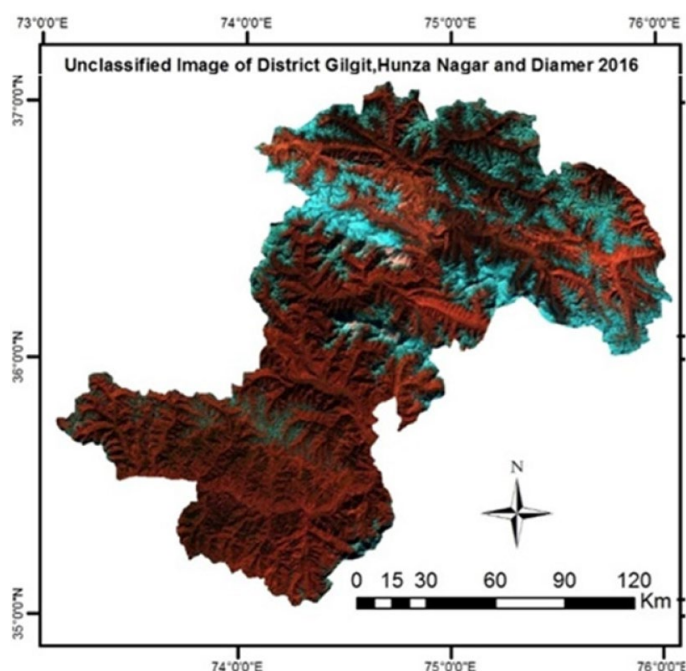


Figure 5: Multi-spectral pre-processed Landsat 8 image of three Sample districts of Gilgit-Baltistan of September/November 2016.

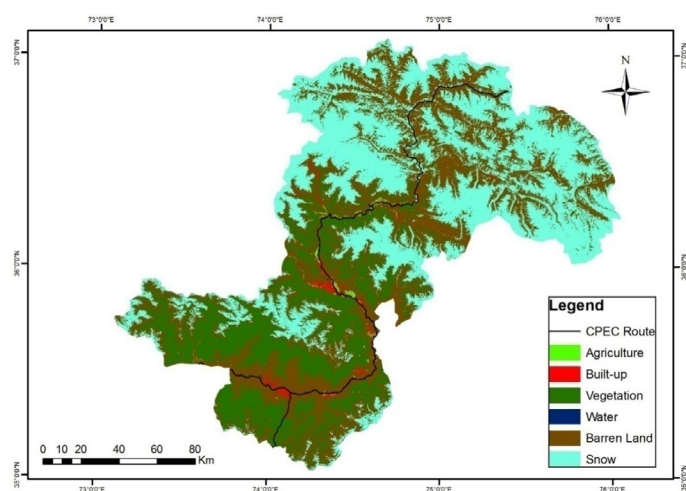


Figure 6: Gilgit-Baltistan, Landsat 8 classified image of Land Use Land Cover of three sample districts of November 2016.

In Gilgit-Baltistan, change in land use land cover indicates that there is a rapid increase in built-up area and a decrease in agricultural land has been noted. The analyzed data reveals that in the three sample districts, in 1996 area under agricultural land was 131.97 Km², which decreased to 90.88 Km² in 2016 and a decrease of -41.09 Km² has been noted. In 1996, the built-up area was 100.52 Km², which increased to 185.46 Km² (0.349%) in 2016 has been registered.

The vegetation cover is increased up to 617.86 Km². The analysis further indicates that both areas under water bodies and barren surfaces decreased by 16.97 Km² and 3,870.98 Km², respectively. Contrary to this, the area under snow cover has increased by 3,184.54 Km² (Table 3; Figure 8 and Figure 9).

Table 2: Gilgit-Baltistan, Land Use Land Cover of three sample districts of 2016.

S. No	Class Name	Area Sq. Km	Area %
1	Agricultural land	90.88	0.36
2	Built-up area	185.98	0.74
3	Vegetation	4,944.44	19.61
4	Water Bodies	41.07	0.16
5	Snow cover	1,0154.70	40.44
6	Barren Land	9,751.92	38.68
Total Area		25,210.14	100

Source: Extracted from Landsat image of November 2016.

Table 3: Gilgit-Baltistan, Land Use Land Cover Change Detection in three sample districts, 1996-2016.

Land use Classes	1996 Area in Km ²	2016 Area in Km ²	Change in Area Km ² 1996-2016
Agricultural land	131.97	90.87	-41.09
Built-up area	100.52	185.98	+85.46
Vegetation	4,326.54	4,944.40	+617.86
Water Body	58.04	41.07	-16.96
Snow Cover	6,970.16	10,154.70	+3184.54
Barren Land	13,622.90	9,751.92	-3870.98
Total	25,206.96	25,210.14	3.17

Source: Extracted from Landsat images of September/November 1996 and 2016.

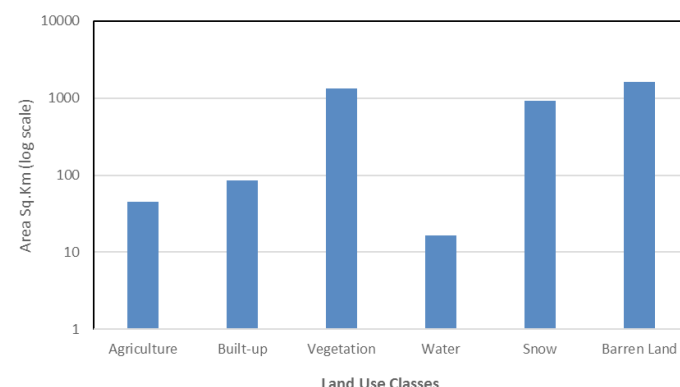


Figure 7: Land Use/Land Cover of the Study area 2016 as per the Landsat image of November 2016.

In Gilgit-Baltistan, Diamer district is rich in vegetation and forests, while other districts have nominal forest cover (Shah et al., 2016). According

to the Ministry of Environment, in GB forest occupy approximately 1,200 square kilometres area. In these forests, Juniper, fir and birch trees are dominating the scene and are in abundance. Before the construction of KKH, these forests were mainly used to meet the local requirements for fuel (firewood) and timber (AKRSP, 2010). Prior to KKH, poor accessibility, lack of communication and non-availability of transport facilities, the timber could not exchange and export to other parts of the country. Hence, during the pre-KKH period, both the local population and the Government could not get benefit fully from these forests.

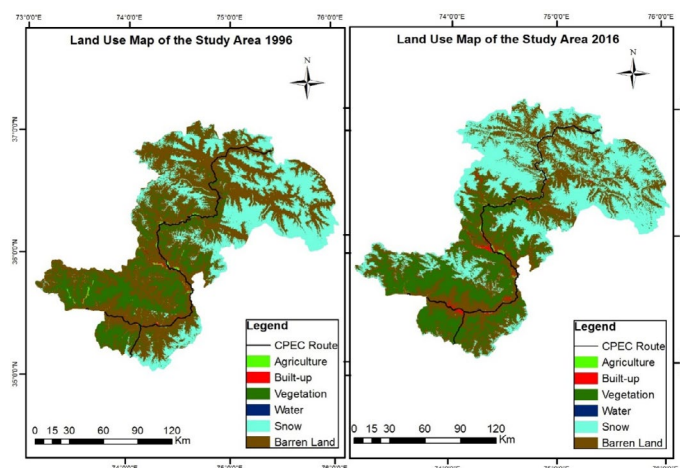


Figure 8: Gilgit-Baltistan, Land Use Land Cover Change Detection in three sample districts from 1996 and 2016

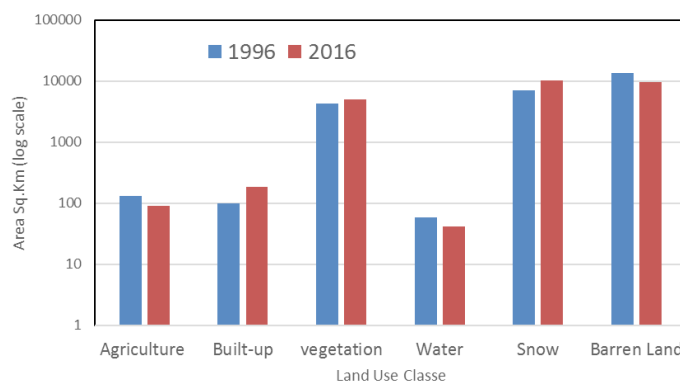


Figure 9: Land Use Land Cover Changes in three sample districts, 1996 and 2016.

Impact of KKH on agriculture

The agriculture sector is considered as the backbone of the Gilgit-Baltistan Economy. Before the construction of Karakoram Highway (KKH), agriculture was one of the backward sectors. Since the availability of water and pastures determine the places of human habitat and people mostly resided along the banks of rivers and water channels in the valley. Therefore, fields are terraced and generally small in size. The entire region is dominantly mountainous and climatically semi-arid

in nature and therefore farmland is scarce and limited to fertile river valleys. As a result, the population pressure is very high on the available cultivable land. Due to regional remoteness, people were not aware of the use of chemical fertilizers, mechanization and the agricultural inputs were old and traditional. Agricultural yields were far below from the level of satisfactory (Kamal and Nasir, 1998).

In the farming system, prior to KKH local population kept a fine balance between growing food and fodder crops, keeping livestock for manure and other animal products and a small orchard for fruit and forest trees for fodder and firewood. The system was sustainable and capable to meet the basic requirements for food, fodder, energy, clothing and other family needs. It must be noted that regular shortages occurred in winter and situation become more vulnerable when crops get to fail and lead to starvation.

In the study area, the main source of income and livelihood is Agriculture and Livestock. During the last 40 years after the inception of KKH, a lot of development occurred and people are earning more besides agriculture but still, agriculture is the major source for a large population. In the study region, incomes from agriculture account for 53% of the total incomes earned by households indicating the importance and role of the agriculture sector in livelihoods earning sources. There is growing opportunity producing cash crops, dry fruits packing and exchange (Dittmann, 1994; Ali, 2004). After the inception of KKH, such radical changes in the agricultural sector are attributed to awareness.

Cropping zones and cropping pattern

In Gilgit-Baltistan, the uncertain climatic condition and vast differences in the altitudinal zones of various localities, in the study area different cropping zones were identified. At the low altitudinal areas such as Gilgit and Chilas, the climate is favourable to practice two cropping pattern, where wheat is a dominant Rabbi Crop and maize as Kharif crop. In these areas, wheat, barley and bean are grown as Rabbi Crops, whereas in Kharif cropping season millet, pulses and other grains are grown. However, at higher elevations, the climatic condition is too harsh and not favourable to grow crops in Kharif and Rabbi Seasons. Over the higher altitudes, the long cold freezing winter does not allow the seeds to germinate. Therefore, a single crop is grown in a year and hence the self-sufficiency

remains very low.

The Table 4 reveals that in Gilgit-Baltistan, the vertical cropping is divided into four cropping zones namely double cropping zone (1200-1600m), marginal double cropping zone-A (1600-2000m), marginal double cropping Zone-B (2000-2400m) and upper single cropping zone (2400-3000m). The agriculture research institute, Gilgit has recently introduced short ripening high yielding seed varieties and it is expected that a positive change in agricultural production will be registered. This will help in getting two crops in a year.

Impact of KKH on agriculture production

In Gilgit-Baltistan, almost all types of vegetables are grown including potato, carrot, radish, turnip, tomato and onion. Being located on high altitudes, good quality of potato is grown in most parts of Gilgit-Baltistan (Kamal and Nasir, 1998; Rahman et al., 2013). Fruits of Gilgit-Baltistan include apple, apricot, mulberry, walnut, grapes, almond, and cherry. Although in the region, better varieties of apple and apricots were available in abundance, but due to non-access to market and non-availability of better storage facilities, a huge quantity of these fruits are wasted. People of the area could not utilize the available agricultural products properly before the construction of KKH.

The construction of KKH has helped in the transfer of

technology and development of the agriculture sector. The farmers of Gilgit, Skardu, Diamer, Hunza-Nagar and the surrounding areas have become accustomed of mechanization and the use of modern tools such as tractors for cultivating, harvesters, transportation of agricultural products and threshing. Fertilizers have been widely used as a major agricultural input after the construction of KKH and the application of chemical fertilizers is gaining importance day-by-day. It is, therefore, the yield of the agriculture sector has increased after the construction of KKH. Table 5 shows the development of agricultural production.

In the study area, the high altitude, climatic and other conditions in isolated valleys of Gilgit-Baltistan are suitable for the production of quality vegetable, production and processing of fruits especially apricots, apples and production of certified potato seeds. Fruits of Gilgit-Baltistan were compatible with the national/international market. The high quality of fruits such as apple, pear, walnut, apricots and cherry are available in the area. The opening of KKH for traffic has helped in bringing the surplus of these fruits commodities into the market. Before the construction of KKH majority of these surplus fruits were wasted (Table 3). Due to the adoption of the developed production techniques, the production of fruits has also been increased considerably.

In Gilgit-Baltistan, during 2012-13 total wheat requirement was 135,000 tons, whereas the local

Table 4: *Gilgit-Baltistan, cropping zones and cropping pattern.*

Name of Zone	Altitude in m	Cropping Areas	Dominant crops
Double Crop Zone	1200-1600	Chilas, Jaglot, Gilgit	Wheat, Maize, Barley, vegetable, clover,
Marginal Double Crop Zone-A	1600-2000	Ghanche, Skardu	Wheat, Maize, Barley, vegetable, clover, millet
Marginal Double Crop Zone-B	2000-2400	Karimabad, Yasin, Kharmang, Khaplu	Wheat, millet, barley, turnip, vegetable
Upper Single Crop zone	2400-3000	Darkut, Phandar, Naltar, Gultari	Wheat, maize, potato, barley

Source: Directorate of Agriculture, Gilgit-Baltistan, 2013.

Table 5: *Gilgit-Baltistan, agricultural production, 2012-13.*

Name of Crop	Yield in ton /ha	District Gilgit in ha	District Ghizer in ha	District Skardu in ha	District Ghanche in ha	District Diamer in ha	Total acreage in ha
Wheat/ Barley	1.8	9,000	7,560	19,800	10800	16,200	63,360
Maize	2.8	9,800	5,600	1,400	-	11,200	28,000
Minor Crops	1.1	220	165	165	55	605	1,210
Total		19,020	13,325	21,325	10,855	28,005	92,570

Source: Directorate of Agriculture, Gilgit-Baltistan, 2013.

production in the same year was 93,000 tons with a deficiency of 43,000 tons (GOGB, 2005). Furthermore, to meet deficit wheat requirements and fulfilment of demands of a growing population, 43,000 tons of wheat was imported.

The construction of KKH and other inter-valley link road has helped in introducing a marketing system. It has helped in exploiting the local agricultural products in both national and international markets. Now the inhabitants of the area could bring their surplus products such as apricots, potato, fruits in the market which were previously gone in waste. The AKRSP is imparting training to village organizations in marketing fresh and dry fruits locally and to other parts of the country.

In the study area, climatic conditions are also suitable for the production of high-quality fruits especially apricot for processing and marketing which has good market potential at home and abroad. The connection of the area through KKH with the rest of the country has brought certain techniques of drying these valuable fruits and has been using in the local market. However, these are a small proportion of the total production. A big proportion is going into waste. The department of Agriculture is collaborating with PCSIR in the processing of apricot. The department has built a solar drying system and the PCSIR has established a fruit processing zone in Gilgit (World Bank, 2011). This can be replicated successfully in other parts of Gilgit-Baltistan. Production of other fruits like cherry, apple, walnut and almond is also in progress.

The construction of KKH facilitated UNDP to launch various agro development-based projects in the area. The area was found suitable for Potato production. As a result, production of potato on a commercial basis has increased manifold. People of the area are seeing a comfortable profit margin with regards to potato production. In 2008, the estimated production of potato was about 82,000 metric tons. It has been estimated that the potato growers of the area earned 756,000 million against this production (Table 7).

The climatic condition and the high altitude of the area are the most appropriate for developing disease-free seed potato. Hence the production and rapid multiplication of disease-free seed potato have increased manifolds. The private seed companies during 2008-10 have produced the following quantity of certified seed potato:

Table 6: Gilgit-Baltistan, area and production of important fruits.

Type of Fruits	No. of trees		Area in hectares	Production in tons		
	Bearing	Non-bearing		Fresh	Dry	Nuts
Apricot	1,035,200	201,571	6,470	60,305	-	-
Apple	48,884	21,898	315	24,442	-	-
Almond	4,456	28,275	315	-	-	883
Grapes	63,902	9,289	399	61,345	-	-
Walnut	5,547	16,542	318	-	-	887
Mulberry	183,680	21,118	1,148	18,225	-	-
Cherry	83,000	37,000	400	1,660	-	-
Pears	11,782	3,518	68	8,247	-	-
Others	139,808	42,826	587	16,938	-	-
Total	1,626,259	382,137	10,000	191,162	-	1,770

Source: Directorate of Agriculture, Gilgit-Baltistan, 2013.

In Gilgit-Baltistan, application of fertilizers, seeds and provision of water are the key agriculture inputs for getting high yields. However, after the KKH, the accessibility increased and the area is linked with main spine routes (Begum, 1986). The highway has opened the study region for commerce and trade. Avenues for employment have been opened and the latest trend and mechanization has been introduced in the agriculture sector. It has also helped in introduction new crop varieties, vegetables and fruits (Table 6 and 7).

Table 7: Gilgit-Baltistan, estimated area and production of table potato 2008-10.

S.No.	Production Area	Area (hec)	Qty (M.T)	Cost (Million)
1.	Gilgit	1680	42000	396.000
2.	Skardu	600	15000	135.000
3.	Ghanche	600	15000	135.000
4.	Ghizar	200	5000	45.000
5.	Diamir	200	5000	45.000
Total		3280	82000	756.000

Source: Directorate of Agriculture, Gilgit-Baltistan, 2013.

Table 8: Certified seed potato production by private seed companies 2008-10.

Name of the company	Areas (ha)	Production (m.t)
Jaffar Brothers Ltd, Lahore	25.8	1880.34
Abdul Ghafoor Bhatti Seed Company, Lahore	14.6	462.69
Jabbar Combine Lahore (JCI)	27.5	932.78
Gilgit Apricot Marketing Association Hunza	6.3	207.62
Total	74.2	3483.33

Source: Directorate of Agriculture, Gilgit-Baltistan, 2013.

Most on-farm activities in the study area are not producing according to its potential whether it is vegetables or wheat and maize crops. The reason behind this low production is accessibility and the high cost of production. That is why besides a vast area and opportunities the production level is still very low as compared to other parts of the country. Another reason for the low production of the wheat crop is the subsidy on wheat from the federal government. The local farmers prefer potatoes production which is also a cash crop and they earn more from it to purchase wheat for their survival (GOGB, 2005). The study reveals that wheat and maize production remained low during the period 2001-2012 (Table 9). The low production of wheat and maize does not affect the agriculture production and lifestyle of the people of the study area because of the permanent supply of wheat from Punjab through KKH. The commercialization process in Gilgit-Baltistan brought a slight fall in some of the production of the fruit as it requires permanent care and attention (Table 9).

Table 9: Major crops and fruits yields in Gilgit-Baltistan.

Crop yields (tons /ha)			Fruit Yields (tons/ 000 trees)		
Crop	2012	2001	Fruit	2012	2001
Potato	17.3	11.2	Cherry	14	19
Barley	1.9	2	Pear	46	52
Maize	2.3	4	Walnut	30	37
Wheat	2.2	2.6	Grapes	40	62
			Mulberry	60	57
			Apple	36	31
			Apricot	62	58

Source: Directorate of Agriculture, Gilgit-Baltistan, 2013.

As mentioned above a decline in some of the crops does not mean that the entire process has stopped but the interest of farmers is shifted towards another crop production. The production of Apple and Apricot shows a positive sign for the local as well as international markets. During the years 2001-2012, as mentioned in the above table the production of both the important fruits, has risen up to 5 per cent. It is also important to mention here that the study area has an enormous potential for potatoes production. In our field survey, we observed that farmers of Gilgit-Baltistan are much aware of the fact that is why they are paying much attention towards the production of this cash crop. According to Agriculture department Gilgit-Baltistan during the last ten years (2001-2012), the 25 per cent increase is recorded in potatoes

production while it has generated revenue as much as Rs. 1000 million (GOGB, 2005).

Mechanization of agriculture

In the study area, KKH has played a pivotal role in the mechanization of agriculture. Prior to the construction of KKH, communication was a major obstacle in the development of agriculture. People using animals for ploughing and threshing are now using modern machinery and technology which has increased the productivity and size of the field (Kamal and Nasir, 1998). The study further reveals a massive development in agriculture machinery including cultivators, rotavators, trolleys, tube wells and lift pumps (Table 10).

In the study area, most of the women are directly engaged in farming. The women take an active part, in farming. The contribution of manual labour by women in the agriculture sector is vital. Before the construction of KKH and the introduction of the tractor, almost all field operations were shared by women and man. In addition, women also worked side by side with their men during ploughing, sowing, harvesting and threshing (Cook and Butz, 2011).

Table 10: Gilgit-Baltistan, comparative status of agriculture machinery, 1994 and 2012.

Major items	1994	2012
Tractors		
Tractors	919	1546
Implements		
Cultivator	152	540
Mould board plough	2	87
Chisel plough	01	13
Rotavator	0	85
Thresher	18	546
Trolley	1293	1445
Tube wells /lift pumps		
All tub wells /lift pumps	0	225
Private	0	175
Government	0	45
Electrics	0	89
Diesel	0	40
Private Tube wells	0	15
Centrifugal	0	2
Turbine	0	3
Well with pump	0	6
Private lift pumps	0	102

Source: Directorate of agriculture, Gilgit-Baltistan, 2013.

After the construction of KKH, and the introduction of tractors and threshers, men take the responsibility of cultivating and threshing, while all other field operations are carried out by women in addition to the care of livestock and household duties. Besides, where men have migrated to seek employment elsewhere, women have taken up the traditionally male responsibilities including ploughing and threshing. Prior to the construction of KKH, the people of Northern Area had no idea of the use of chemical fertilizers; they generally used dung. The supply of inputs like fertilizers did not reach the area due to its remoteness. In order to improve soil fertility, they had to rely entirely on dung. After the construction of KKH, chemical fertilizers were for the first time introduced. As a result, farmers saw an increased yield of wheat and other commodities. Almost 100% of farmers now use chemical fertilizers in addition to dung (AKRSP, 2012).

In Nalter however, only 30% of the households use chemical fertilizer mainly because they cannot afford to purchase it, due to the high cost of transportation from Gilgit to Nalter. According to Gilgit-Baltistan census of Agriculture 1980, 53% of the farmers were reported to be using both chemical fertilizer and dung. However, the 1985 wheat crop survey by AKRSP showed that about 79% of the farmers of Gilgit district were now using chemical fertilizer in addition to dung (Kamal and Nasir, 1998).

The survey analysis of Nalter reveals that farmers prefer to use dung as compared to chemical fertilizers. This is because it is easily available. Besides, Nalter is a single-cropped area where the emphasis is, on livestock breeding. Every household has some livestock, which gives some dung.

The second important factor is the inaccessibility of the area. Nalter is connected to Gilgit by a highly unstable road which often remains closed due to frequent land sliding. This difficulty of access also prohibits the farmer to use chemical fertilizer.

Nitrophos fertilizers are the most commonly used by the wheat growers. The other fertilizers used are Urea and Nitrate. None of the farmers used DAP. It was argued that the soil has low nitrogen level, but adequate phosphorus and potassium levels. DAP has 46% of phosphate. Local soils are not deficient in Phosphate. Hence this type of introduced crop

varieties as compared to local varieties. On an average 65 Kg/hectares of nitrogen and 40 Kg/hectares of phosphorous are used on wheat crop (Alam et al., 2012).

Due to its remoteness and non-accessibility with the other regions, the local people of the study area rely upon agriculture and livestock. The harsh terrain and inhospitable environment in most of the area was another hurdle besides proper irrigation for the low production. The poor peasants took a sigh of relief after the construction of KKH, due to which the deficiency of grains and food items in the area reached frequently. As mentioned above the difficulties facing the local farmers and due to lack of policy making for sustainable development of the agriculture sector in Gilgit-Baltistan is still lagging behind (AKRSP, 2012). Despite all the challenges and hurdles, the enthusiastic farmers have not given up and they are transforming their centuries-old traditional farming to a more dynamic and modern technique. Again it is the accessibility from cropping area to the local and international markets as well as to the other provinces which is encouraging the farmer and peasants to grow more and more agricultural products. Prominent among the growing crop production is Potato, Apple and cherry.

The analysis reveals that the study area has enormous potential to increase agriculture production which is only 1% of the total area. It requires a long-term policy to mitigate the problems of local farmers and encourage them to grow more crops. KKH is serving as a lifeline for the study area but linking the vast area to KKH is also a mammoth task, developing infrastructure and providing modern technology with educating the farmers is desperately needed (Ali, 2004). Pakistan is blessed with the enormous potential of agriculture and dairy products as it stands no five in dairy production. The study area needs attention to utilize this potential. Huge infrastructural development requires government attention as well as an international investment but to get benefits from that investment is also a challenge. China is investing a lot in the energy sector under CPEC in different parts of Pakistan in which Gilgit is also included.

Processing of agricultural products

In the study area processing of agricultural products is negligible. The reason for this is obvious as the production level is low and the distances within

the region are very high so the poor farmers did not have the capacity to process the products. That is why the waste rate of vegetables and fruits is also high. Accept an apricot which is not wasted all the fruits and vegetables in the study area are sold fresh in the market as well as other parts of the country. It is not only the case in the research area but all over Pakistan farmers do the same practice. The exporters or the buyers in the big markets have the capacity to process these items and they normally do. The study area shows a high wastage rate because of its low production levels (World Bank, 2011). Labelling and packing export quality Honey is another good option for the local people associated with this profession. The traditional style of meat processing is still followed especially in the winter season due to snowfall. Another important and high-value product is woollen dresses and carpets a little expensive due to its high cost and time consumption. Furniture products and wooden construction material examples of forest-based processing. Deforestation is bearing negative impacts on the environment and tourism. Its only remedy is to grow more and more forests.

Marketing of agricultural products

In the study area marketing of agricultural products is still low. People mostly produce crops for their domestic needs, not for commercial advantages. Potato is the main cash crop of most of farming activity. Potato production has 82% percent share in the overall cash crops market. In fruits production Apples, Cherries, apricot and almonds are having a greater share. The level of value as well production can be increased by giving much attention to these valuable fruits (Sokefield, 2014).

The environment and climatic conditions of Gilgit-Baltistan are very much favourable for vegetable and fruits like potatoes, apricot and cherries. Potatoes and cherry crops are picked in June and July which provides an edge to this area over other parts of Pakistan because their picking time is February and march. So the study area is not only self-sufficient in potato production but also provides seed potatoes to other provinces. The average supply of seed potatoes is estimated as many as 23000 metric tons (AKRSP, 2012). the area has possessed the high potential for more production if the government, as well as local community, take a keen interest in developing the agriculture sector. The up gradation of KKH has brought many socio-economic changes e.g. chemical

fertilizers are available at subsidized rates in the local markets, banking facilities which were once a dream for the local populace are now a reality. The future of Gilgit-Baltistan is very bright as for as agriculture and fruits production is concerned.

The analysis reveals that the study area has different climatic conditions and cropping patterns from other provinces. Excluding fruits production, most of the farming areas produce one crop in a year which minimizes the incomes of farmers and agriculture-related activities. Most of the mountains in the study area are dry and barren except Diamer and Hunza valley (Mahmud, 2008). Due to this tough mountainous terrain, only one percent in the vast area of Gilgit-Baltistan falls under cultivable land.

Restricted agricultural activities have negative impacts on overall incomes. It is obvious because only one percent land is used for farming. Patchy agriculture process becomes expensive for the farmers in terms of low incomes. Accumulation and adjustment of farm production for marketing and processing purpose is a mammoth task. In the Agriculture sector low income and production of one crop badly affects the income of another crop. In the study area, most of the farmers prefer those crops which provide forage for their animals, so it also affects the standard of farming activities and creates hurdles for development in this sector (Stellrecht, 1997).

Long distance from one area to the other in harsh mountainous terrain and detachment from the markets is also a big problem. Although KKH has broken up their isolation from the rest of the country still the distance is high enough for the fresh and fragile fruits. It requires high standard vehicles that make it sure to bring these quality products in good form for the local market as well as for export. Storage facilities are also lacking in the study area which is highly recommended due to the above-mentioned difficulties. Only 500 metric ton potatoes are stored in the available resources (World Bank, 2011).

The construction of KKH has helped in the transfer of technology and development of the agriculture sector in a visible way. The farmer of Gilgit HQ, Skardu HQ and Chilas HQ and the surrounding areas have become accustomed to the use of modern tools such as tractors for ploughing, transportation of goods and threshing purposes. Fertilizers have been widely using

in the post KKH era. The use of chemical fertilizers is increasing day by day. The yield of agriculture sector has increased after the construction of KKH. The following table shows the development of agricultural production.

Further to meet deficit wheat production, Government was able to import at average 20,000 tons' wheat on subsidized rates in the area beside 22,000 tons by the private sector. Details are as under:

Total food-grain required	135,000 tons
Local production	93,000 tons
Deficiency	43,000 tons
Supply of subsidized wheat	20,000 tons
Receiving through private dealers	22,000 tons

The building of KKH and other inter-valley link road has helped in introducing a marketing system. It has helped in exploiting the local Agricultural products in the national/international markets. Now the inhabitants of the area could bring their surplus products such as apricots, potato, fruits in the market which were previously gone in waste. The N.G.Os especially AKRSP are imparting training to Village Organizations in the marketing of fruits to the down country.

The high altitude, the climatic and other condition as well as dry and isolated valleys of Gilgit-Baltistan are highly suitable for the production of quality vegetable seeds, production and processing of fruits especially apricots and apples and production of certified potato seeds (Clemens and Nuesser, 1995-96).

Fruits of Gilgit-Baltistan were compatible with the national/international market. The high quality of fruits such as apple, pear, walnut, apricots and cherry are available in the area. The opening of KKH for traffic has helped in bringing the surplus of these fruits into the market. In the pre-KKH era, a vast majority of these surplus fruits were gone in waste. Due to the adoption of the developed production techniques, the production of fruits has also been increased considerably.

The climatic and other conditions are also highly suitable for the production of high-quality fruits especially apricot for processing and marketing, which has good market potential at home and abroad.

In the pre-KKH era, the vast quantity of apricots was gone into rotting. But in the post-KKH era, certain techniques of drying these valuable fruits have been using and a huge quantity of these have been brought in the local market. However, these are a small proportion of the total production. A big proportion is going into waste. The Department of Agriculture is collaborating with PCSIR in the processing of apricot. The department has built a solar drying system and the PCSIR has established a fruit processing zone in Gilgit (GOP, 2005).

This can be replicated successfully in other parts of Gilgit-Baltistan as well. Production of other fruits like cherry, apple, walnut and almond is also in progress. The opening of KKH has resulted in encouraging the people of Northern Areas to develop fruit orchards and the inter-cropping of alfalfa.

The construction of KKH facilitated UNDP and FAO to launch various agro development based projects in the area. The area found suitable for Potato production. As a result, production of potato on a commercial basis has increased manifold. People of the area seeing a comfortable profit margin with regards to potato has started producing potato at a larger scale. In 1996, the estimated production of potato was about 82,000 metric tons. It has been estimated that the potato growers of the area earned 756,000 million against this production.

The climatic condition and the high altitude of the area are the most appropriate for developing disease-free seed potato. Hence the production and rapid multiplication of disease-free seed potato have increased manifolds. The private seed companies during 1996-97, have produced the following quantity of certified seed potato.

Impact of KKH on livestock

The study reveals that low productivity in the livestock sector is also of high concern. Livestock products such as milk, meat, wool and leather are of great importance for the local people as well as for traditional products. The number of animals in the study area has increased manifold during the years 1996 to 2006 (Table 11, Figure 10). The analysis reveals that despite small increase in livestock the whole area is still facing a deficiency of milk and meat production. The deficiency is covered by tetrapacks synthesized milk and other dairy products supplied from Rawalpindi through KKH.

The study area is blessed with natural vegetation and naturally fit environment for many types of livestock. After the construction of KKH, the interaction of local community with other parts of the country encouraged the local populace to develop this sector as well. The following table and graph show a detailed picture of Livestock development in the study area.

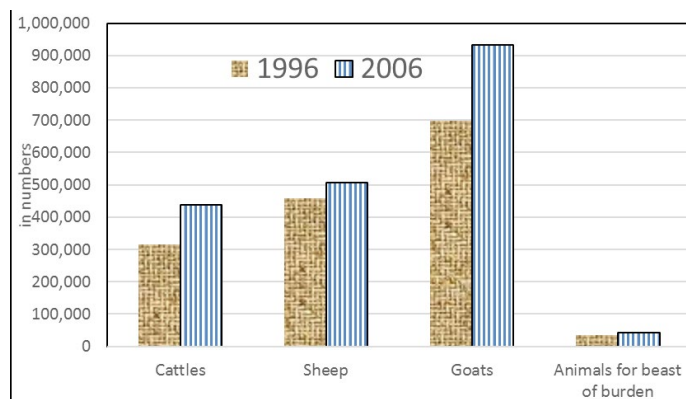


Figure 10: *Gilgit-Baltistan, Changes in the number of livestock in 1996 and 2006 as per livestock and agriculture census.*

Table 11: *Gilgit-Baltistan, comparative status of livestock census 1996 and 2006.*

Types of animal	Livestock census		% variation in 2006 over 1996
	1996	2006	
Milk and meat animals			
Cattle (Cow and Ox)	315,337	434,851	(+) 38
Buffaloes	629	2,263	(+) 260
Sheep	458,132	506,155	(+) 10
Goats	697,669	931,821	(+) 34
Draft animals			
Camels	141	186	(+) 32
Horses	4,279	5,097	(+) 19
Mules	649	1,014	(+) 56
Asses	15,164	21,138	(+) 39
Yaks	14,914	16,319	(+) 09

Source: Directorate of Agriculture, Gilgit-Baltistan, 2013.

Implications for agricultural development

In the research area, there is great potential for agricultural development. The first and foremost barrier is the harsh mountainous terrain. Irrigation facilities are very limited in the already limited agriculture sector. One of the reasons for low production is a small size split farmland. All these implications are further aggravated by the distances from farm to market. Again the importance of accessibility is evidence which proves the significance of KKH for Gilgit-Baltistan. Link roads connecting KKH and the remote valleys are still in bad condition and it requires

proper arrangements (World Bank, 2009). Although the federal and provincial governments are paying attention to bring long term improvements in this sector but still it's lagging behind and requires more attention.

Conclusions and Recommendations

To conclude the paper, it was found that the land of Gilgit-Baltistan is mostly virgin with adequate water resources and responsive beneficiary communities. However, rugged topography, poor infrastructure, small fragmented landholdings and lack of trained and experienced manpower are the main hurdles in agricultural development. The climate of Gilgit-Baltistan is ideally suited for the production of good quality fruits and off-season vegetables. Gilgit-Baltistan has the potential to produce good quality of fruits, vegetable and seeds. Natural calamities, urbanization and population explosion are the potential threats to the agricultural development of Gilgit-Baltistan.

The fruits and vegetables are rich sources of vitamins and other nutrients. These are high-value cash crops and the main source of income of rural population in GB. The government is giving high priority to the development of agriculture in general and vegetables and fruits in particular. Nevertheless, a large proportion of fruits and vegetables produced are wasted owing to in-efficient marketing system, lack of storage facilities and food processing zones etc. such a situation, if allowed to persist, will certainly work against the growing commercial activities in this sector. Small land holdings and mostly the agricultural land is single cropped and almost one-third of farmland is double cropped. Food grain production for human consumption is on the lower level. Efforts have therefore been made to diversify agriculture for the production of quality vegetable seeds and fruits to reduce the pressure of imports. Vegetable seeds produced in Gilgit-Baltistan are more healthy and cheaper as compare to the imported seeds.

The government of Gilgit-Baltistan and Pakistan is aware of the problems and is keen to remove the bottlenecks. However, the development of physical infrastructures such as roads, markets, cold storages and provision of support services need more attention and investments. It is also important to mention here that globally focus is shifting from plain agriculture

to mountain agriculture. In plains, the major factors of production including soil, water and ecology have been largely overexploited and polluted due to indiscriminate use of synthetic chemicals. The mountain agriculture, in spite of all ailments, is still far behind that stage. It offers good prospects for organic produce and can thus develop growing markets in Pakistan.

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Author's Contribution

Salman Anwar: Proposed research, performed research, collection of data, analyses of data, writing manuscript.

Farhan Anwar Khan: Contributed in writing manuscript.

Atta-ur-Rehman: Preparation of research proposal, analyses of data, writing manuscript

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